Transient & Cosmology Studies in the High Latitude Time Domain Survey

Proposers (name/affiliation): Rebekah Hounsell (UMBC), Masao Sako (Penn) , David Rubin (UH), Nao Suzuki (LBNL), Brad Cenko (NASA GSFC) *on behalf of the HLTDS Core Community Survey Definition Committee, and the Roman SN Cosmology Project Infrastructure Team*

Subaru Instrument: Subaru PFS & HSC

Number of nights (hours): 40 shared nights (asking for a fraction of fibers, so ~150,000 fiber hours) on PFS, 20 nights on HSC

Condition of nights (moon phase, airmass, seeing): Dark, airmass < 1.5, seeing < 1.0”

Time critical (year, season, date, time): Very time critical. Continuous observations are required during the HLTDS with a cadence of ~ once a month on PFS and higher cadence on HSC over the northern HLTDS field while it is visible. PFS observations should be weighted towards the end of HLTDS as the number density of target SN host galaxies increases.

Relevant CCS/other Roman program: HLTDS (+ HLWAS for their “deep” field, if overlap) & RAPID

Category(exoplanet, galaxies, large scale structure, solar system, stellar physics, stellar population/ISM, super massive blackhole/AGN, IGM/CGM): Broad applications, but with a focus on Type Ia SNe, Core Collapse SNe, Stellar physics, Transients, Galaxy Evolution, Variable Stars, AGN

Key words: Cosmology, Transients, Time Domain, Galaxies, Redshifts

High Latitude Time Domain Survey Key Objectives

1. Roman is a wide near infrared survey instrument and within the HLTDS the community will conduct detailed studies of a variety of objects.
2. Roman is a Stage IV dark energy mission and must provide a Dark Energy Task Force Figure of Merit of 326 or greater.
    - SN Ia are one of our most mature cosmological probes
    - Roman must obtain a significant sample of well observed SN Ia across a broad range of redshifts to achieve this objective
    - The Roman prism will likely only be utilized ~20% of the time during the HLTDS
    - Spectroscopic redshifts for all SN Ia and their hosts with Roman is therefore not feasible
    - Subaru is vital for obtaining spectroscopic redshifts and deep optical imaging for all SNe and the majority of their hosts.

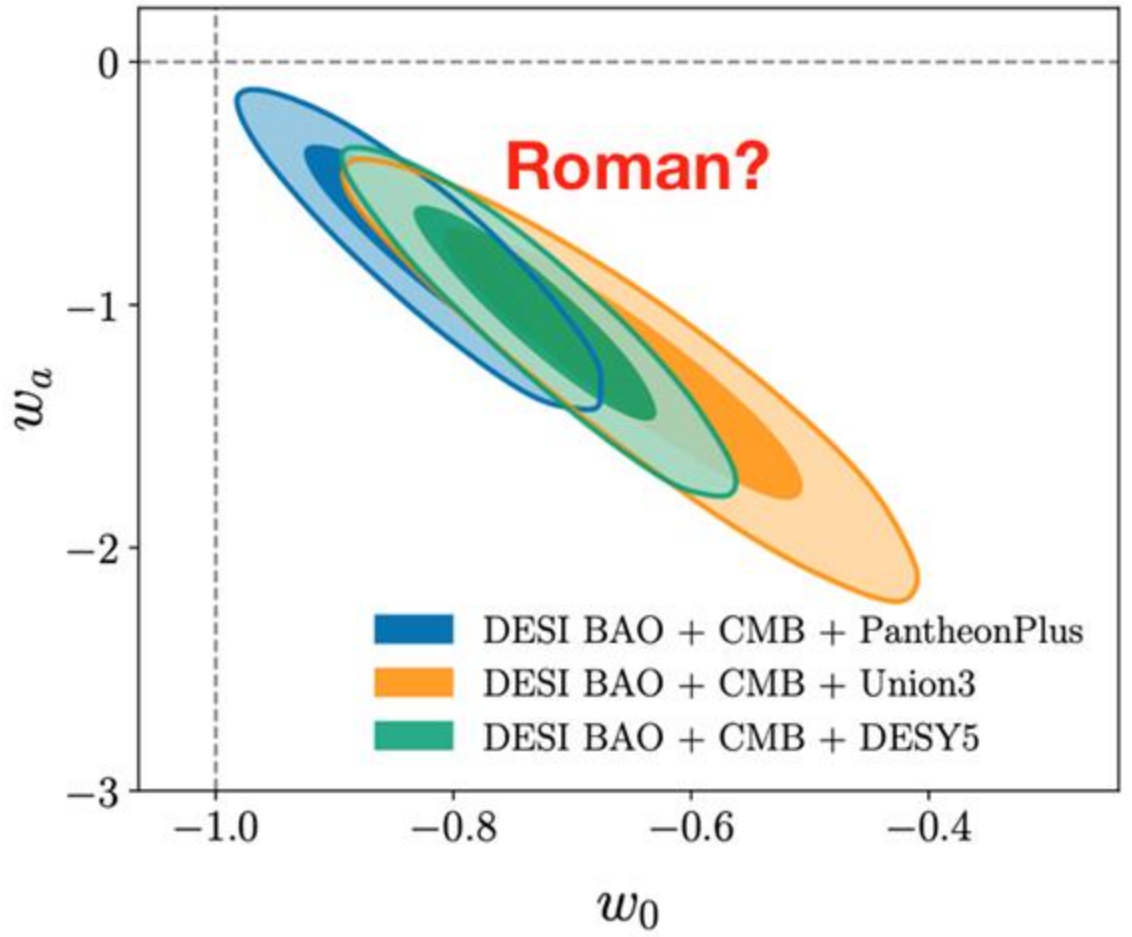
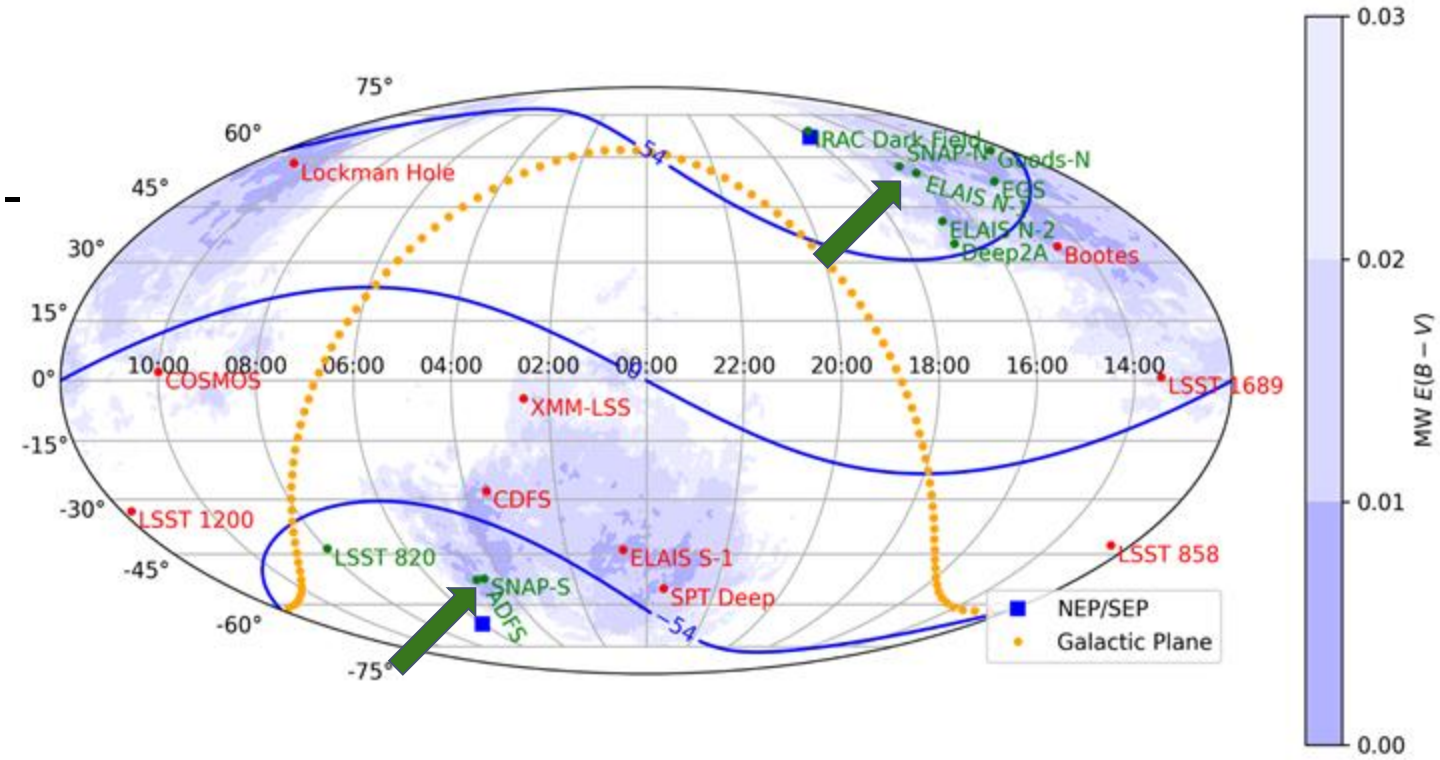


Image take from DESI Collaboration (2024)

HLTDS Design

- HLTDS Fundamentals:
  - Wide (30 - 50 deg^2) and Deep Tier (1-5 deg ^2)
  - Likely split to observe in both the northern and southern continuous viewing zones
  - Only northern has good visibility from Subaru
  - Six months total observing time uniformly spread over two years (middle two years of five-year survey)
  - Cadence of 10/5 days (interlaced)
  - Minimum four filters per tier
  - ~20% total prism time
  - ~80% imaging time



Possible continuous viewing zones - green. Other deep fields - red. Low MW dust extinction - blue shading. Top choices ELAIS N1 and Euclid South Deep. Modified Image from Rose et. al., 2021

Subaru Specifics: How much time and why

- For PSF an average of ~1 hr per lunar month/pointing to target live SNe, other transients, and variable sources.
  - Perhaps more for the Deep tier
  - Total of ~300 hrs so 30 nights or with weather losses 40 nights.
    - Note that we will only use a fraction of the fibers within these pointings
  - Start with a few fibers in the first pointings and build to < 1000 per pointing by the end of the HLTDS
  - **Total request of ~150,000 fiber hrs**
  - *Strong need for other programs to contribute targets in deep fields, for example HLWAS*

- Host galaxies + other field galaxies should be targeted continuously after the SN occurs
  - This will build the S/N for host-galaxy studies and allow for redshifts to be obtained for hosts and field galaxies
    - Field galaxies are used to evaluate host misidentification, weak-lensing corrections, and intergalactic extinction along the line of sight
    - For live transient observations, we want a deep set of spectra when transient is not present to evaluate the transient's host contamination

- For HSC, obtain deep optical imaging (grizy) of the northern HLTDS area
  - Complement Roman infrared imaging data
  - Approximately 1 night of observations for each deg^2; tentatively 20 deg^2 = 20 nights

Summary

Significance of Synergy: The synergy between Roman's wide-field infrared imaging and Subaru's deep optical imaging and spectroscopic capabilities offer complementary strengths that will enable a wide range of scientific investigations that includes cosmology, transient astronomy and stellar astrophysics, galaxy evolution, and early-universe objects.